JACOBS®

Memorandum

1515 Poydras Street, Suite 1260
New Orleans, LA 70112
United States
www.jacobs.com

Subject	**Turbine Cooling Water Assessment Workshop**
Project Name	Power Plant Cooling Water System Analysis
Attention	Sewerage and Water Board of New Orleans
From	Jacobs Engineering Group Inc.
Date	January 31, 2019
Copies to	Bob Turner

1. Executive Summary

At the request of the Sewerage and Water Board of New Orleans (SWBNO), Jacobs Engineering Group Inc. (Jacobs) performed a study of the Carrollton Power Plant cooling water system in 2018 as part of the HMGP Retrofit Power Plant Project. The purpose of the study was to develop reasonable alternatives to optimize the functionality of the existing steam turbines for efficient power generation, which supports the drainage pump stations around the City of New Orleans during rain events. The steam turbines at SWBNO's Carrollton Water Treatment Plant (WTP) require cooling water to condense the steam from the turbines used to generate electricity. Based on water quality and temperature requirements for this function, treated water from the Carrollton WTP has been used as cooling water. This assessment concluded that water was being reintroduced into the finished water clear well without additional treatment. This is typically classified as a cross-connection and is not allowed under current state or national drinking water regulations.

Following the submittal of the assessment in December 2018, SWBNO requested that Jacobs facilitate a Turbine Cooling Water Assessment Workshop to fully understand the impacts from various perspectives and chart a path forward to mitigate the cooling water issues without impacting public health or hindering plant operations. The purpose of this technical memorandum is to summarize the conclusions and solutions discussed during the workshop.

Facilitation of the workshop included establishing the problem frame, which consists of three key categories: 1. Public Health, 2. Power Generation, and 3. Water Distribution/Delivery. One of the main goals of the workshop was to develop solutions to address the cross-connection issue. At the end of the workshop, six potential projects were identified to mitigate the cooling water cross-connection without sacrificing the key focus of public health, power generation, and water distribution.

The proposed plan developed with SWBNO during the workshop is a response plan to reduce cooling water usage; it is possible to completely decouple interconnected systems within approximately 3 years while maintaining operations of critical drainage and water distribution infrastructure for the City of New Orleans.

2. Introduction and Problem Frame

The steam turbines at SWBNO's Carrollton Power Plant require cooling water to condense the steam from the turbines used to generate electricity. Based on water quality and temperature requirements for this function, treated water from the Carrollton WTP has been used as the source of cooling water. As this water enters each of the steam turbine condensers, the temperature should be approximately 87 degrees Fahrenheit (°F) during summer operation. Currently, if the water enters the condenser at or near 95°F, it is the result of recirculation of this cooling water in the clear water well and inadequate flow of the heated water away from the cooling water pump suction points. This means that the existing cooling water system is not providing optimally cool water for full capacity and efficient power generation. A review of the existing power plant cooling water system was conducted to confirm the system configuration and identify any potential hindrance to the overall system performance.

Jacobs completed the initial tasks related to the cooling water system review in November 2018. The goal of the study was to better understand the system configuration, cooling water flows, potential impacts to potable water quality, and to provide options for a closed-loop cooling water system or other acceptable alternatives that meet the capacity and efficiency requirements for the Carrollton WTP and Power Plant Complex assets, collectively referred to as the Carrollton Water Plant (CWP). The draft report of this study was issued November 30, 2018, with the final report of this study scheduled to be issued in January 2019.

Additionally, it was identified in the draft report that cooling water was being reintroduced into the finished water clear well without additional treatment. This is typically classified as a cross-connection and is not allowed under current state or national drinking water regulations.

At the request of SWBNO, Jacobs prioritized and facilitated a Turbine Cooling Water Assessment Workshop to discuss the results and recommendations presented in the draft report. The focus of the workshop was based on SWBNO's objective to identify the most effective future management of finished (potable) water, power production and final distribution/delivery. Meeting notes from the workshop are provided as Attachment 1.

Figure 2-1 schematically shows the general path of the water into and out of the clear water well at the CWP. The area of interest for the workshop is located at the cross-connection points between the power plant cooling water and the potable water clear well, identified by the broken-line box.

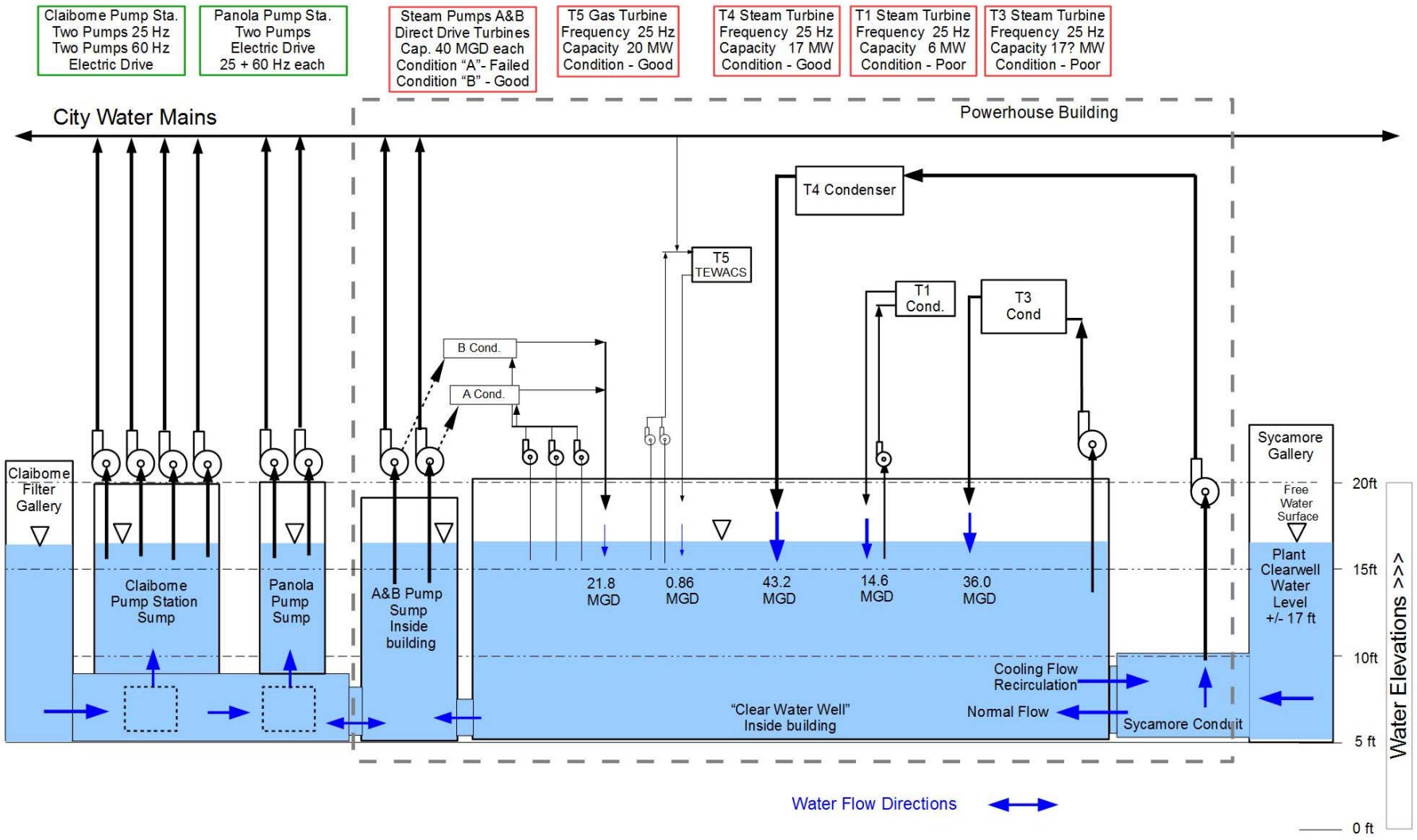


Figure 2-1. Overall Clearwell Schematic

General flow of water into and out of the clear water well at the CWP

2.1 Overall Problem Frame

Decision makers in utilities and organizations face important consequential decisions such as the cooling water issues from time to time. Generally, these types of decisions are infrequent, complex, difficult to make, and involve many uncertainties. In the case of the CWP cooling water system, the decisions and associated courses of action involve an irreversible commitment of substantial resources and/or redefining the direction of SWBNO operations for years to come. A formal approach that incorporates reliability, risk, and consequences is needed to achieve decision quality.

The formal approach to the Turbine Cooling Water Assessment Workshop includes a problem statement and the associated problem frame, which filters out what is not pertinent to the specific problem at the moment. In many cases, complex decisions with relatively high amounts of uncertainty indicate more than one problem. In this case, the overall issue associated with the cooling water system has three sub-issues: power generation, potable water quality, and pumping of potable water to the distribution system (two high-service pumps are water-cooled with the same type of water used in power generation, and cooling water temperature and flow are influenced by the operation of the distribution pumps sourcing water from the clear water well). Each of the sub-issues has its own set of consequences, some of which are unintended in terms of the overarching issue and solutions. The first two sub-issues were prioritized for assessment during the workshop.

The overall problem statement used for the workshop was “to identify the most effective future management of finished (potable) water through power production and final distribution/delivery.”

Problem framing starts by asking questions about the purpose of the decision and examines various perspectives. Three components of problem framing are goals/purpose, perspective, and scope. Following review of the draft problem statement, a problem frame was developed for the overall issue (cooling water use) and two sub-issues (power generation and water quality). The facilitated session developed the goals, perspectives, and scope that was included, or excluded, from each frame.

The overall problem frame outlined in Figure 2-2 was prepared during the workshop with the assistance of all attendees. The items inside the frame include items open for discussion during the workshop. The items outside the frame are identified as important to the problem statement but excluded from the solutions discussed during this workshop. Further details on the items included inside the overall problem frame are outlined as sub-issues in subsequent sections of this technical memorandum.

Inside the Frame	Outside the Frame
Power generation	Incoming water quality
Public health (cross-connection)	Funding resources
Water production/distribution	Legislative/regulatory modifications
Reliability of Sycamore Filter Gallery	Stakeholders
Additional monitoring points	Stormwater/sewer drains (oil coolers) accessed by the powerhouse
Additional monitoring compounds	
Sampling frequency	
Louisiana Department of Health (LDH)	
Inspection of clearwell	
Startup of equipment	
Change in raw water demand	
25-hertz (Hz) power/power conversion	
Standard operating procedure (SOP) maintenance (closed loop)	
Costs	
Feasibility	

Figure 2-2. Overall Problem Frame – Cooling Water Use at the CWP

3. Public Health and Safety

The overall problem frame was divided into sub-issues. The first sub-issue is public health and safety related to the public drinking water system at the Carrollton WTP and its cross-connection to the power plant cooling water system (Figure 3-1). Per the original design, the powerhouse steam turbines use treated drinking water to facilitate steam condensation. The water is then returned to the plant clear water well, where water is pumped into the distribution system. Applicable regulations in specifically prohibit the discharge of water used for cooling into the potable water system. The regulations were developed to address the potential health risk of contamination of potable water by industrial chemicals and by industrial work practices (potentially unsanitary). The current approach at the Carrollton WTP is not in compliance with the regulations. It is noted that the samples collected for the cooling water study showed compliance with potable water standards, and SWBNO has identified that they are in compliance with primary drinking water standards and have multiple sampling points within the distribution system that reflect compliance.

Inside the Frame	Outside the Frame
Add water quality monitoring points in the drinking water system	Legislative/regulatory
Monitor additional compounds during routine water quality testing	Stakeholders
Increase water quality monitoring frequency	Carrollton WTP treatment
Update the SOPs for maintenance	Algiers WTP
Inspect the wet well	
Communicate with LDH	

Figure 3-1. Sub-Issue Problem Frame – Public Health and Safety

The following are potentially significant consequences for public health and safety if the cross-connection is not reduced or eliminated:

1) Potential contamination of potable water supply
2) Noncompliance with regulations
3) Citizen perception of SWBNO

The previously completed report provided an analysis on a number of water samples collected in 2018 and historical routine sampling, technical analysis of the cooling water and power systems, and potential alternatives. The recent workshop validated that the potential solutions were consistent, and sufficiently broad, to fully address the problem statement and frames developed in the workshop. The potential alternatives are as follows:

1) Post-powerhouse water treatment, prior to reintroduction of cooling water into the potable water system
2) Use untreated water from the Mississippi River for cooling
3) Stepped reduction in cooling water usage, with enhanced monitoring of water quality in the cooling water system (Preferred)
4) Turbine No. 5 (T5) becomes primary operating turbine for 25-Hz power production (Preferred)
    a) Develop additional maintenance procedures to manage the cross-connected systems as potable water systems. For example, purging water-cooled equipment before bringing it online. (Preferred)

4. Power Generation

The second sub-issue resulting from the overall problem frame is the power generation system and its reliance on the cooling water system for critical power generation Figure 4-1.

Inside the Frame	Outside the Frame
Condenser tube contamination	Legislative/regulatory
SOPs for equipment maintenance	Stakeholders
Backflow prevention for oil water coolers	
25-Hz power conversion to 60-Hz power for system flexibility	
Raw water use as an alternative cooling source/impacts on equipment	
Equipment startup procedures	
Cost	
Feasibility – overall lifecycle costs	

Figure 4-1. Sub-Issue Problem Frame – Power Generation

The following are potentially significant consequences for the power generation system if the cross-connection is not reduced or eliminated were identified as follows:

1) May not produce sufficient 25-Hz power due to high temperature cooling water
2) May not provide sufficient pumping capacity for raw water and finished water distribution due to reduced power production
3) Alternative water source (raw water) decreases power equipment reliability
4) Contamination of the clear well during power equipment startup or during maintenance operations

The previously completed report provided a substantial amount of data collection, technical analysis, and potential alternatives. The workshop validated that the potential solutions were consistent, and sufficiently broad, to fully address the problem statement and frames developed in the workshop. The preferred alternatives are as follows:

1) Supplement Turbine No. 1 (T1) capacity with Electro-motive diesel (EMDs) – in progress
2) Eliminate Turbine No. 3 (T3) and replace with a static frequency changer
3) Install a new air-cooled heat exchanger for T5
4) A&B pumps
    a) Leave pumps in place and replace steam drive with electric motor (Preferred), or
    b) Install new pump station and new electric driven pumps

5) Turbine No. 4 (T4)
   a) River water cooling – pipe chase and heat exchanger, or
   b) Re-route the cooling water discharge to the beginning of the water treatment process (Preferred)

5. Decision Criteria

The decision criteria underscore the values and logic used by the organization to make a decision. In this workshop, reviewing the decision criteria provided another method for validating that the problem frame and potential alternatives were both sufficient and robust. Sound reasoning is a product of well-developed decision criteria.

A common failure point in quality decision making for complex problems with uncertainty is that the decision criteria are not established explicitly. The workshop established an initial list of decision criteria, which should be refined later with final decision makers. The key initial decision criteria are the following:

- Ease of understanding for the stakeholders, and ease of implementation with the current operational priorities.
- Financial – capital costs and payback
- Increase reliability/reduce customer complaints – no boil water orders, no flooding, sufficient water pressure
- Perception associated with noncompliance
- Environmental responsibility – potential emissions reductions will be realized by reconfiguring the power generation system

6. Proposed Solutions

Proposed solutions to address the overall problem statement and eliminate the cooling water cross-connection are outlined in Table 6-1. During the workshop, a priority ranking was assigned to each solution based on criticality and ease of implementation. After the workshop, a Class 5 cost estimate and conceptual schedule of implementation was prepared for each solution. Class 5 cost estimates are provided as Attachment 2 and schedules are included in Attachment 3.

The phased reduction and ultimate elimination of the cooling water cross-connection at the CWP is displayed on Figure 6-2. Based on preliminary estimates of costs and timing, the cross-connection could be eliminated in less than 3 years and for less than $18 million. The workshop identified funding as a necessary factor in achieving this goal, however various funding mechanisms were not discussed in detail.

Table 6-1. Proposed Solutions

Priority	Solution	Time Frame	Class 5 Cost	Comments
1a	• Enhance water quality monitoring	0	$0	This project is in progress and being led by SWBNO
1b	• Employ EMD in lieu of T1 with intent to eventually decommission	5 months	$50,000	This project is in progress with SWBNO Potentially reduces cooling water demand by up to 14.6 million gallons per day (mgd)
2	• T5 becomes primary 25-Hz turbine – Update and enhance SOPs for maintenance – Update and enhance SOPs for startup	6 months	$100,000	T4 is currently operated as the primary 25-Hz turbine. By switching to T5, potential cooling water usage is reduced from 43.2 mgd.(T4) to 0.86 mgd (T5). See Figure 6-1
3	• Electrify A&B pumps	14 months	$3,900,000	21.8-mgd potential reduction in cooling water demand
4	• Add air-cooled heat exchanger to T5	15 months	$860,000	Reduces potential cooling water demand by 0.86 mgd
5	• Eliminate T3 and install a static frequency changer	28 months	$10,800,000	Reduces potential cooling water demand by 36.0 mgd
6	• Reroute cooling discharge for T4	25 months	$1,800,000	Reduces potential cooling water discharge to the finished water system by 43.2 mgd The schedule for this project can begin approximately 7 months after the rest of the program begins to accommodate equipment availability

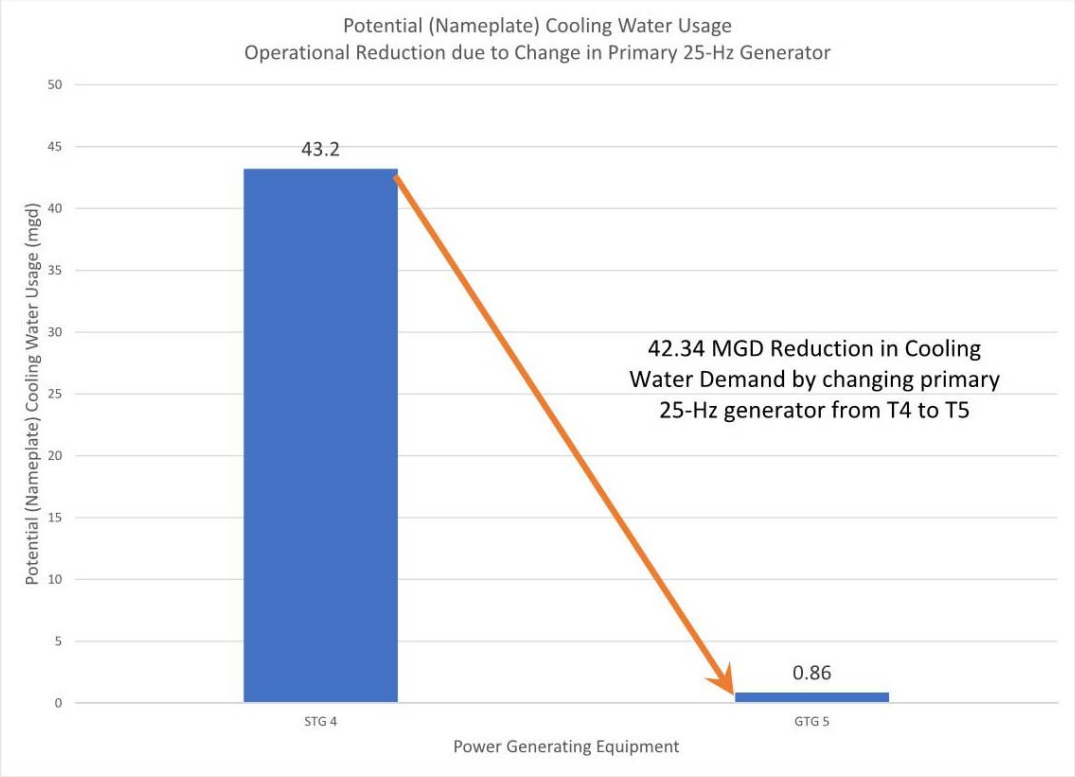


Figure 6-1. Reduction in Cooling Water Usage Due to Operational Change

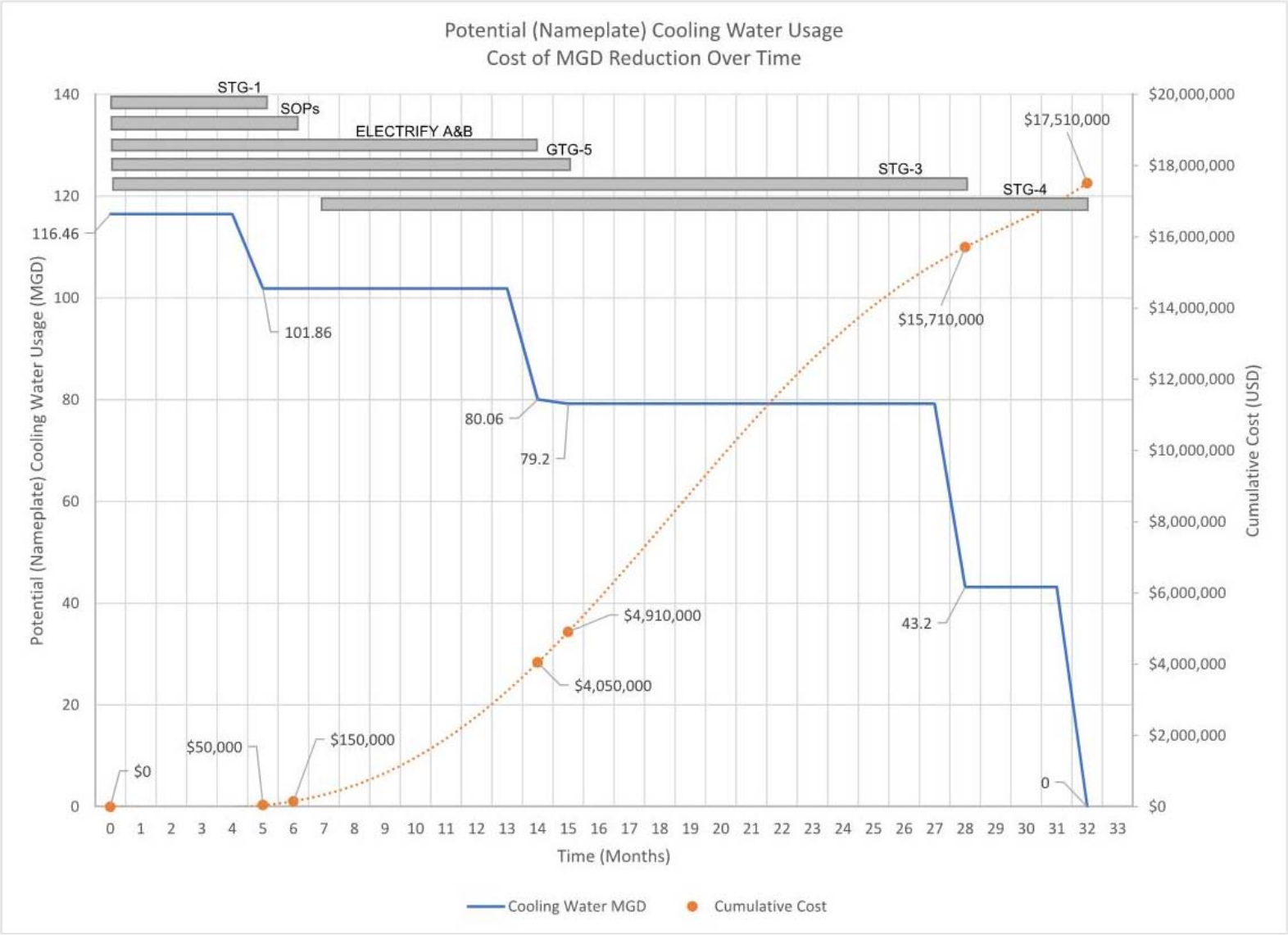


Figure 6-2. Phased Reduction of Cooling Water Usage

7. Communication Plan

Based on the discussion and results of the workshop, the next logical step is to communicate the issue to the appropriate regulatory stakeholders. For this subject matter, it is recommended that SWBNO initiate communication with LDH as soon as possible. It is recommended that communication with LDH include the following:

- A timeline and plan for achieving compliance with existing cross-connection legislation and conformity with industry standards for drinking water safety.
- Presentation of water quality data collected as part of the cooling water study and additional sampling plans and data currently being collected by SWBNO.
- A monitoring and sampling strategy to ensure drinking water safety and due diligence prior to system decoupling. This should include grab sampling and online instrumentation (chlorine residual and turbidity) on the outlet side of the A&B pumps.
- A plan for ensuring drinking water department awareness/oversight of the power plant cooling water system.
- Other drinking water treatment plant deficiencies (previously identified by LDH) that may be able to be addressed as part of the cooling water decoupling project.

To display full transparency, it is also recommended that SWBNO disclose the results of the cooling water study to SWBNO customers and stakeholders. The power system, potable water system, and cooling water system are highly complex systems, and their connection points are also significantly complex. In communication with the customers of SWBNO in the future, this may be facilitated by simplified flow diagrams and data representation, such as:

- A streamlined process flow diagram of the cooling water system and its connection with other systems; the diagrams developed for the cooling water study are a potential starting point to create this material.
- A simplified plan view diagram of the clear water well and its location relative to the powerhouse, water towers, and other key landmarks such as the adjacent football field may be developed as part of the external communication tools in aiding the customer's understanding of this subject.
- A simplified 3D isometric-style drawing that shows the flow of water from the clear water well through the cooling water system, running adjacent to power generation components, and returning to the clear water could illustrate the actual interconnection points and clarify where they exist, and do not exist by design.
- SWBNO has indicated that current data confirm that potable water distributed to the water distribution system meets primary potable water criteria; therefore, a communication plan that includes a simplified subset of this data (e.g., visuals of results within ranges over time) is recommended as key stakeholder communication material.
- A timeline of construction of the clear water well and power house equipment, as well as maturation of the regulations applicable to potable water use.

Attachment 1
Workshop Meeting Notes

Power Plant Cooling Water Study Assessment Workshop

PREPARED BY:	Jacobs
PROJECT:	Power Plant Cooling Water Study /469936.18.CW
MEETING DATE:	January 8, 2019
MEETING TIME:	10:00 – 1:30 am CST
LOCATION:	SWBNO Carrollton Water Plant, 2nd Floor Conference Room
ATTENDEES:	SWBNO: *Damon Adams, Kevin Burfect, Mary Dubourg, Eric Labat, Chad Lavoie, Samuel Lewis, Benjamin Poole, Ron Spooner, Bob Turner* Jacobs: *Rodney Carpenter, Shane Dempsey, Amanda Gaze, Ken Mains, Ron Menze, Sonya Reiser, Yahya Rokayak, JD Solomon, Herb Tull, Kaitlin Tymrak, Greta Zornes*

Agenda Items

a. Health and Safety

5-minute safety topic – *Fire extinguishers – regular inspections and selection of the proper extinguisher for the type of fire*

b. Discussions Items

1) *Objective of the meeting is to identify the 'most effective management in the future of finished (potable) water through power production and final distribution/delivery.*
   a) *Jacobs developed preliminary report on findings of cooling water system study, initiated by SWB concerns that proper cooling isn't occurring. Findings indicates that there are multiple cross-connections between turbine cooling water system and potable water distribution system, as well as concerns that existing system cannot provide sufficient cooling for power demand.*
   b) *This workshop is to discuss the risks of this condition. Risk is defined in several ways: 1) the effect of uncertainty on objectives; 2) deviation from project objections/expectations; and/or 3) surprises.*
   c) *In this situation, the risks are grouped into two categories: risk to power production, and risk to public health.*
   d) *Questions/topics to discuss during the meeting:*
      i) *What is the potential for surprises?*
      ii) *What are the greatest risks and how can they be mitigated (immediate vs short term vs long term)?*
      iii) *A meeting will Louisiana Department of Health will occur in the near term, the goal of this meeting is to provide a framework of a plan and due diligence on protection of public health, to be used in those discussions.*
   e) *At this time, the risk assessment is focused on the system 'downstream' of the sycamore filter gallery (i.e. not on water treatment plant).*
2) *Risks to power generation*
   a) *Risks of current system configuration:*

i) *Cannot produce sufficient 25Hz power*
ii) *Cannot provide sufficient pumping capacity for raw water and finished water distribution*
iii) *Alternative water source decreases power equipment reliability*

b) *Sycamore filter gallery output has a large influence on power generation. Repair work at sycamore filter gallery is currently on hold - funds have been prioritized for power projects, and work that is being done is being driven by power needs, rather than water treatment needs.*
c) *There are no flow meters at Sycamore. After planned rehab, the Sycamore gallery is expected to produce 60 MGD; it was approximately 112 MGD at initial design.*

3) *Public health*
a) *Risks:*
i) *Non-compliance*
ii) *Citizen perception*
iii) *Civil lawsuits*
iv) *Contamination*
b) *There are no other known cross-connections than those identified in the report. All maintenance fluids are sent to sewer.*
c) *Water treatment system is currently meeting all state and federal water quality regulations.*
d) *Routine water distribution system testing occurs for general chemistry and VOCs. Planning to start routine testing in the power plant, including metals.*
e) *Testing of city water is done on a routine basis by universities, USDA, etc. Details of testing and for what constituents are not known.*
f) *The location of the power plant over the clearwell is a risk to public health. Turbine operations staff are not trained in drinking water protection, but they are 'in charge' of a clearwell. Contractors working in this space are also not aware.*
g) *Need to start internal inspections of clearwell integrity.*
h) *CWP is inspected by LDH every 2-3 years, but no known clearwell inspections to date*
i) *There are other outstanding deficiencies from recent LDH inspections.*
i) *Is it possible to install online turbidity, pH, and chlorine meters at each turbine outlet? That would provide an indication of contamination, but not a substitute for frequent monitoring.*
j) *Algiers drinking water plant was rehabbed in the 90s's; no known or suspected issues similar to this situation at that location.*

4) *Power generation alternatives (to reduce steam demand)*
a) *T1: Jacobs proposes to use EMDs as a supplement*
i) *T1 and EMDs are on separate breakers, but they cannot operate at the same time. EMDs will be a supplement or alternative to T1, not a replacement*
b) *T3: Jacobs proposing a new 20 MW static frequency converter*
i) *Current bus could likely handle 20 MW, but electrical engineering would have to verify (breakers, cables, switching, etc)*
ii) *A 20 MW dedicated load is unlikely from a practical perspective, however*
iii) *Could use the extra bus on the 1370A SG for the 60 hz load from new FC*
iv) *A static frequency changer is great in concept, but may be too far out right now - but we do want to move in this direction*
v) *A new FC could be fed from either T6 or Entergy*
(1) *Can start up quickly, and it's not a problem to run at a lower load than max capacity*
(2) *This equipment is often used for railroads in the northeast - strong incentive to accelerate at maximum speed*
c) *T5: Jacobs proposes dry cooler*
i) *T5 becomes the primary turbine.*
d) *A&B steam pumps: Jacobs proposes to move the clearwell for A&B or build a new pump station with all electric pumps*

i) *Need to maximize investment on 1351 contract, this is not a short-term solution. Trade-offs need to be included in discussions. CP 1351 costs are sunk costs, the question is how long it will take to get the investment back with a new solution*

e) *T4: Jacobs proposes use of closed-loop river water cooling*
   i) *There are concerns regarding the use of raw water for turbine cooling, due to increased likelihood of debris/sediment/fouling in condenser tubes, as well as in condensate return to boilers.*
   ii) *Proposed solution is dependent on all other CW users being removed/replaced*
   iii) *Need a backup plan for emergency feed pumps for boilers*
   iv) *Could it be cost effective to install a new generator?*
   v) *The load on T4 would also be reduced due to the new FC - would be only needed for drainage. Easier to justify an A&B conversion to electric than a removal of T4*
   vi) *Potential scenario*
      (1) *Leave A&B in place, convert pumps to 60 hz electric, reducing steam demand*
      (2) *T4 becomes emergency use only, because new FC, EMDs, and T6 carry the majority of the load*
      (3) *Need to consider dry weather constant duty pumps at the DPS - potential conversion to 60-hz motors*
      (4) *Having FC's that can be paralleled onsite is a big plus*

5) *Decision criteria for alternatives*
   a) *Capital cost + payback in O&M savings*
   b) *Long term cost*
   c) *Reliability*
      i) *No preventable flooding*
      ii) *No boil water advisories*
      iii) *Customer complaints*
   d) *Perceived results of non-compliance*
   e) *Consider environmental impacts*
      i) *Emissions reductions*
      ii) *Less gas purchased*

6) *Discussion with LDH*
   a) *EPA reviews the work of LDH. If the point comes to negotiating a consent order, then the public trust is already lost. There is already a consent order for sewer. But drinking water is a different issue in the public's mind.*
   b) *LDH should be aware of city budget constraints. The negotiation will be around timeframe of implementation of a corrective action plan, not a reduction in regulations.*
   c) *Outside stakeholders will not be involved at this time.*
   d) *Critical infrastructure designation may have an impact on LDH response*
   e) *Need SWB Board Members to be properly educated on the situation and potential outcomes*
      i) *How this situation came to be*
      ii) *Ramifications*
      iii) *Path forward and timeframe*
   f) *Need to go to LDH or the Board first?*

7) *Gaps/unknowns*
   a) *Understanding of citizen perception and response*
   b) *Timeframe of meeting with LDH*
   c) *Timeframe of implementation (as required by LDH)*
   d) *Monitoring (as required by LDH)*
   e) *Third party water quality testing results*
   f) *Funding availability*

c. Summary / Action Items

- *Jacobs to summarize discussion into tech memo that can be used by SWB for internal discussions*

Attachment 2
Costs

Project name	19-006 SWBNO_T3 to Frequency Changer
Labor rate table	NOS&WB Labor Rates
Equipment rate table	1_BlueBook_2018_100%
Report format	Sorted by 'ITEM/Component/Task' 'Detail' summary Combine items

ITEM	Component	Task	Description	Takeoff Quantity	Labor Productivity	Labor Hours	Labor Amount	Material Price	Material Amount	Sub Price	Sub Amount	Equip Price	Equip Amount	Other Price	Other Amount	Total Amount
10			**Frequency Changer in Powerhouse #2**													
	20		**Civil/Structural**													
		200	**New 8" x 20' x 50' Concrete Floor**													
			Concrete pumping, subcontract	25.43 cy			-	-	-	15.00 /cy	381	-	-	-	-	381
			Forms in place, elevated slab, soffit	1,000.00 sf	0.400 mh / sf	400	18,308	1.25 /sf	1,250	-	-	-	-	-	-	19,558
			Strip elevated slab soffit forms	1,000.00 sf	0.140 mh / sf	140	4,746	-	-	-	-	-	-	-	-	4,746
			Forms in place, elevated slab, edge form	93.33 sf	0.500 mh / sf	47	2,136	1.25 /sf	117	-	-	-	-	-	-	2,253
			Strip elevated slab edge forms	93.33 sf	0.175 mh / sf	16	554	-	-	-	-	-	-	-	-	554
			Slab shoring	20,000.00 cf	0.014 mh / cf	280	12,815	0.08 /cf	1,500	-	-	-	-	-	-	14,315
			Remove slab shoring	20,000.00 cf	0.006 mh / cf	120	4,068	-	-	-	-	-	-	-	-	4,068
			Accessories, form oil, allow 750 sf/gal	1,093.33 sf	250.000 sf / mh	4	200	15.00 /gal	22	-	-	-	-	-	-	222
			Reinforcing in place, A615 Gr 60, priced per lbs.	3,456.79 lb			-	0.55 /lb	1,901	0.24 /lb	830	-	-	-	-	2,731
			Concrete, ready mix, 4500 psi	24.69 CY			-	165.00 /CY	4,074	-	-	-	-	-	-	4,074
			Add for concrete waste, 4500 psi	0.74 CY			-	165.00 /CY	122	-	-	-	-	-	-	122
			Placing concrete, concrete pump, for elevated slab to 12" thick	24.69 cy	1.000 mh / cy	25	835	-	-	-	-	-	-	-	-	835
			Finishing floors, monolithic, trowel finish (machine)	1,000.00 sf	0.040 mh / sf	40	1,356	0.02 /sf	20	-	-	-	-	-	-	1,376
			Curing, membrane spray	1,000.00 sf	250.000 sf / mh	4	135	0.06 /sf	60	-	-	-	-	-	-	195
			Metal deck, open type, galv., 4-1/2" deep, 16 gauge	1,000.00 sf	25.000 sf / mh	40	2,055	-	-	2.50 /sf	2,500	85.00 /mh	340	-	-	4,895
			200 New 8" x 20' x 50' Concrete Floor			1,116	47,208		9,066		3,711		340			60,325
		210	**Demolish Exist Transformer Pads**													
			Demo Existing Concrete Transformer Pads	1.00 ls	80.000 mh / ls	80	2,712	-	-	-	-	55.00 /mh	1,100	-	-	3,812
			210 Demolish Exist Transformer Pads			80	2,712						1,100			3,812
		220	**New Transformer Pads**													
			Fine grade, for slab on grade	960.00 sf	0.016 mh / sf	15	519	/sf		-	-	0.01 /sf	8	-	-	527
			Fill, sand subbase, under building slab on grade	11.85 cy	1.500 mh / cy	18	601	21.00 /cy	249	-	-	-	-	-	-	850
			Concrete pumping, subcontract	105.46 cy			-	-	-	15.00 /cy	1,582	-	-	-	-	1,582
			Slab on grade edge forms, 7" to 12"	234.67 sf	0.360 mh / sf	84	3,867	1.35 /sf	317	-	-	-	-	-	-	4,183
			Strip edge forms, 7" to 12"	234.67 sf	0.126 mh / sf	30	1,002	-	-	-	-	-	-	-	-	1,002
			Forms in place, structural walls, > 8' to 16' high, hand set	8,448.00 sf	0.400 mh / sf	3,379	154,663	1.50 /sf	12,672	-	-	-	-	-	-	167,335
			Strip/Move structural wall forms, > 8' to 16' high, hand set	8,448.00 sf	0.140 mh / sf	1,183	40,095	-	-	-	-	-	-	-	-	40,095
			Accessories, chamfer strip, PVC, 3/4" chamfer w/leg	704.00 lf	0.030 mh / lf	21	982	0.39 /lf	275	-	-	-	-	-	-	1,257
			Accessories, form oil, allow 750 sf/gal	8,682.67 sf	250.000 sf / mh	35	1,590	15.00 /gal	174	-	-	-	-	-	-	1,763
			Waterstop, PVC, center bulb, 9" wide	384.00 lf	0.160 mh / lf	61	2,812	8.00 /lf	3,072	-	-	-	-	-	-	5,884
			Reinforcing in place, A615 Gr 60, priced per lbs.	14,269.63 lb			-	0.55 /lb	7,848	0.24 /lb	3,425	-	-	-	-	11,273
			Concrete, ready mix, 4500 psi	101.93 CY			-	165.00 /CY	16,818	-	-	-	-	-	-	16,818
			Add for concrete waste, 4500 psi	3.53 CY			-	165.00 /CY	583	-	-	-	-	-	-	583
			Placing concrete, concrete pump	23.70 cy	1.500 mh / cy	36	1,202	-	-	-	-	-	-	-	-	1,202
			Placing concrete, concrete pump, for structural wall to 12" thick	78.22 cy	1.700 mh / cy	133	4,495	-	-	-	-	-	-	-	-	4,495
			Finishing floors, monolithic, float finish	960.00 sf	0.040 mh / sf	38	1,302	0.01 /sf	10	-	-	-	-	-	-	1,311
			Patch & plug tieholes	8,448.00 sf	0.030 mh / sf	253	8,568	0.02 /sf	169	-	-	-	-	-	-	8,737
			Sack rub	704.00 sf	0.080 mh / sf	56	1,904	0.03 /sf	21	-	-	-	-	-	-	1,925
			Curing, membrane spray	9,408.00 sf	250.000 sf / mh	38	1,272	0.06 /sf	564	-	-	-	-	-	-	1,837
			220 New Transformer Pads			5,381	224,874		42,771		5,007		8			272,659
		230	**Concrete Pad for Dry Cooler (Assume Outdoors)**													
			Fine grade, for slab on grade	400.00 sf	0.016 mh / sf	6	216	/sf		-	-	0.01 /sf	3	-	-	220
			Hand Excavation, General Labor Crew	14.82 cy	4.000 mh / cy	59	2,009	-	-	-	-	-	-	-	-	2,009
			Fill, sand subbase, under building slab on grade	4.94 cy	1.500 mh / cy	7	250	21.00 /cy	104	-	-	-	-	-	-	354
			Concrete pumping, subcontract	35.65 cy			-	-	-	15.00 /cy	535	-	-	-	-	535
			Accessories, chamfer strip, PVC, 3/4" chamfer w/leg	80.00 lf	0.030 mh / lf	2	112	0.39 /lf	31	-	-	-	-	-	-	143
			Accessories, form oil, allow 750 sf/gal	253.33 sf	250.000 sf / mh	1	46	15.00 /gal	5	-	-	-	-	-	-	51
			Reinforcing in place, A615 Gr 60, priced per lbs.	1,382.72 lb			-	0.55 /lb	760	0.24 /lb	332	-	-	-	-	1,092
			Concrete, ready mix, 4500 psi	33.95 CY			-	165.00 /CY	5,602	-	-	-	-	-	-	5,602
			Add for concrete waste, 4500 psi	1.70 CY			-	165.00 /CY	280	-	-	-	-	-	-	280
			Placing concrete, concrete pump	33.95 cy	1.500 mh / cy	51	1,722	-	-	-	-	-	-	-	-	1,722
			Finishing floors, monolithic, float finish	400.00 sf	0.040 mh / sf	16	542	0.01 /sf	4	-	-	-	-	-	-	546
			Curing, membrane spray	400.00 sf	250.000 sf / mh	2	54	0.06 /sf	24	-	-	-	-	-	-	78
			230 Concrete Pad for Dry Cooler (Assume Outdoors)			145	4,952		6,811		867		3			12,632
			20 Civil/Structural			6,722	279,746		58,648		9,584		1,451			349,428
	60		**Electrical**													
		600	**Demolish 18MW Turbine Generator & Switchgear**													
			Demolish Existing 18MW Turbine Generator (12 men @ 18 days)	1.00 ls	2,160.000 mh / ls	2,160	120,398	-	-	-	-	85.00 /mh	8,160	-	-	128,558
			Demolish Existing 25Hz; 6600 volt Switchgear (5 men @ 10 days)	1.00 ls	500.000 mh / ls	500	27,870	-	-	-	-	85.00 /mh	3,400	-	-	31,270
			Demolish Existing Conc. Floor 8" x 20' x 50' (5 men @ 3 days)	1.00 ls	200.000 mh / ls	200	11,148	-	-	-	-	85.00 /mh	2,720	-	-	13,868
			Misc. Demolition & Cleanup (8 men @ 10 days)	1.00 ls	800.000 mh / ls	800	44,592	-	-	-	-	85.00 /mh	5,100	-	-	49,692
			600 Demolish 18MW Turbine Generator & Switchgear			3,660	204,008						19,380			223,388
		610	**Purchase New Electrical Equipment (ABB quote)**													
			Purchase New Electrical Equipment	1.00 ls			-	3,400,000.00 /ls	3,400,000	-	-	-	-	- /ls	-	3,400,000
			610 Purchase New Electrical Equipment (ABB quote)						3,400,000							3,400,000
		620	**Install New 20 MVA Frequency Changer**													
			Install New 20 MVA Frequency Changer	1.00 ls	96.000 mh / ls	96	5,351	-	-	-	-	85.00 /mh	170	-	-	5,521
			620 Install New 20 MVA Frequency Changer			96	5,351						170			5,521
		625	**Install New Input Transformers**													
			Install New 7,500 kVA, 13.2 kV to 3kV	3.00 ea	48.000 mh / ea	144	8,027	-	-	-	-	85.00 /mh	510	-	-	8,537
			625 Install New Input Transformers			144	8,027						510			8,537
		630	**Install New Output Transformers**													
			Install New 7,500 kVA, 3kV to 6.6kV	3.00 ea	48.000 mh / ea	144	8,027	-	-	-	-	85.00 /mh	510	-	-	8,537
			630 Install New Output Transformers			144	8,027						510			8,537
		635	**Furnish & Install Dry Cooler for Frequency Changer**													
			F&I Dry Cooler; 2 MM BTU/Hr Heat Rejection	1.00 ea	40.000 mh / ea	40	2,230	175,000.00 /ea	175,000	-	-	85.00 /mh	255	/ea		177,485
			635 Furnish & Install Dry Cooler for Frequency Changer			40	2,230		175,000				255			177,485
		640	**Conduit, Cable, & Ductbank**													

ITEM	Component	Task	Description	Takeoff Quantity	Labor Productivity	Labor Hours	Labor Amount	Material Price	Material Amount	Sub Price	Sub Amount	Equip Price	Equip Amount	Other Price	Other Amount	Total Amount
		640	Conduit, Cable, & Ductbank													
			Ductbank w/conduit	275.00 lf	3.500 lf / mh	79	4,380	85.00 /lf	23,375	-	-	50.00 /mh	982	-	-	28,737
			XHHW Copper Stranded 1/C # 750	4,200.00 lf	0.060 wkhr / lf	252	14,046	17.70 /lf	74,340	-	-	-	-	-	-	88,386
			640 Conduit, Cable, & Ductbank			331	18,426		97,715				982			117,123
			60 Electrical			4,415	246,068		3,672,715				21,807			3,940,590
			10 Frequency Changer in Powerhouse #2			11,137	525,814		3,731,363		9,584		23,258			4,290,019
20			New Primary Feeder from Joilet Substation to SWB Boundry													
	60		Electrical													
		640	Conduit, Cable, & Ductbank													
			Ductbank w/conduit	4,300.00 lf	2.750 lf / mh	1,564	87,157	85.00 /lf	365,500	-	-	50.00 /mh	19,545	-	-	472,203
			XHHW Copper Stranded 1/C # 750	4,300.00 lf	0.120 wkhr / lf	516	28,762	17.70 /lf	76,110	-	-	-	-	-	-	104,872
			640 Conduit, Cable, & Ductbank			2,080	115,919		441,610				19,545			577,074
			60 Electrical			2,080	115,919		441,610				19,545			577,074
			20 New Primary Feeder from Joilet Substation to SWB Boundry			2,080	115,919		441,610				19,545			577,074
30			Turbine 6 Unit Substation													
	60		Electrical													
		612	Purchase New Electrical Equipment													
			1200 A Bus bar	1.00 ea	36.000 mh / ea	36	2,007	15,000.00 /ea	15,000	-	-	85.00 /mh	170	-	-	17,177
			Vacuum Type Circuit Breakers	4.00 ea	40.000 mh / ea	160	8,918	35,000.00 /ea	140,000	-	-	85.00 /mh	1,020	-	-	149,938
			Transformer, 34.5kV to 13.8kV	1.00 ea	40.000 mh / ea	40	2,230	225,000.00 /ea	225,000	-	-	85.00 /mh	255	-	-	227,485
			612 Purchase New Electrical Equipment			236	13,155		380,000				1,445			394,600
		640	Conduit, Cable, & Ductbank													
			XHHW Copper Stranded 1/C # 500	960.00 lf	0.098 wkhr / lf	94	5,244	9.48 /lf	9,101	-	-	-	-	-	-	14,345
			GRC Conduit @ Level 1 2-1/2"	320.00 lf	0.450 wkhr / lf	144	8,027	8.04 /lf	2,573	-	-	-	-	-	-	10,599
			640 Conduit, Cable, & Ductbank			238	13,271		11,674							24,944
			60 Electrical			474	26,425		391,674				1,445			419,544
			30 Turbine 6 Unit Substation			474	26,425		391,674				1,445			419,544
40			60Hz Feeder T6 Unit Substation to SFC Unit Substation													
	60		Electrical													
		640	Conduit, Cable, & Ductbank													
			Ductbank w/conduit	650.00 lf	1.750 lf / mh	371	20,703	85.00 /lf	55,250	-	-	50.00 /mh	2,321	-	-	78,275
			XHHW Copper Stranded 1/C # 500	1,950.00 lf	0.098 wkhr / lf	191	10,652	9.48 /lf	18,486	-	-	-	-	-	-	29,138
			640 Conduit, Cable, & Ductbank			563	31,355		73,736				2,321			107,413
			60 Electrical			563	31,355		73,736				2,321			107,413
			40 60Hz Feeder T6 Unit Substation to SFC Unit Substation			563	31,355		73,736				2,321			107,413

Estimate Totals

Description	Amount	Totals	Hours	Rate	Cost Basis	Cost per Unit	Percent of Total
Labor	699,513		14,253.0 hrs				6.49%
Material	4,638,382						43.07%
Subcontract	9,584						0.09%
Equipment	46,570		743.0 hrs				0.43%
Other Costs							
Sub Total	5,394,049	5,394,049					50.08%
Material Tax	301,495			6.500 %	C		2.80%
Equipment Rental Tax	3,027			6.500 %	C		0.03%
Bonds & Insurance	144			1.500 %	C		0.00%
Sub Total	304,666	5,698,715					2.83%
Contractor Field GC's	569,872			10.000 %	T		5.29%
Contractor OH&P	854,807			15.000 %	T		7.94%
Sub Total	1,424,679	7,123,394					13.23%
Jacobs Engr. (thru detail deisgn)	854,807			12.000 %	T		7.94%
Sub Total	854,807	7,978,201					7.94%
Project Contingency	2,792,371			35.000 %	T		25.93%
Total		**10,770,572**					

Project name	19-006 SWBNO_Dry Cooling for Turbine 5 (T5)
Labor rate table	NOS&WB Labor Rates
Equipment rate table	1_BlueBook_2018_100%
Report format	Sorted by 'ITEM/Component/Task' 'Detail' summary Combine items

ITEM	Component	Task	Phase	Item	Description	Takeoff Quantity	Crew	Labor Productivity	Labor Hours	Labor Rate Table	Labor Price	Labor Amount	Material Price	Material Amount	Sub Price	Sub Amount	Equip Productivity	Equip Hours	Equip Rate Table	Equip Price	Equip Amount	Other Price	Other Amount	Total Amount
10					**Civil/Structural**																			
	20				Civil/Structural																			
		230			Concrete Pad for Dry Cooler & Pumps																			
			02310.441	1110	Fine grade, for slab on grade	400.00 sf	Conc 02	0.012 mh / sf	5	NOS&WB Labor Rates	33.81 /mh	162	/sf	-	-	-			1_BlueBook_2018_100%	0.01 /sf	3	-	-	165
			02315.441	0001	Hand Excavation, General Labor Crew	14.82 cy	Gen 02	3.000 mh / cy	44	NOS&WB Labor Rates	33.90 /mh	1,507	-	-	-				1_BlueBook_2018_100%	-	-	-	-	1,507
			02315.506	2110	Fill, sand subbase, under building slab on grade	4.94 cy	Conc 02	1.125 mh / cy	6	NOS&WB Labor Rates	33.81 /mh	188	21.00 /cy	104	-	-			1_BlueBook_2018_100%	-	-	-	-	292
			03001.100	0110	Concrete pumping, subcontract	35.65 cy			-			-		-	15.00 /cy	535				-	-	-	-	535
			03150.160	2200	Accessories, chamfer strip, PVC, 3/4" chamfer w/leg	80.00 lf	Conc 01	0.023 mh / lf	2	NOS&WB Labor Rates	45.77 /mh	84	0.39 /lf	31	-	-			1_BlueBook_2018_100%	-	-	-	-	115
			03150.850	3050	Accessories, form oil, allow 750 sf/gal	253.33 sf	Conc 01	333.333 sf / mh	1	NOS&WB Labor Rates	45.77 /mh	35	15.00 /gal	5	-	-			1_BlueBook_2018_100%	-	-	-	-	40
			03210.601	1110	Reinforcing in place, A615 Gr 60, priced per lbs.	1,382.72 lb			-			-	0.55 /lb	760	0.24 /lb	332				-	-	-	-	1,092
			03310.221	1320	Concrete, ready mix, 4500 psi	33.95 CY			-			-	165.00 /CY	5,602	-	-				-	-	-	-	5,602
			03310.221	2320	Add for concrete waste, 4500 psi	1.70 CY						-	165.00 /CY	280	-	-				-	-	-	-	280
			03310.701	2110	Placing concrete, concrete pump	33.95 cy	Conc 02	1.125 mh / cy	38	NOS&WB Labor Rates	33.81 /mh	1,291	-	-	-	-			1_BlueBook_2018_100%	-	-	-	-	1,291
			03350.301	1110	Finishing floors, monolithic, float finish	400.00 sf	Conc 03	0.030 mh / sf	12	NOS&WB Labor Rates	33.90 /mh	407	0.01 /sf	4	-	-			1_BlueBook_2018_100%	-	-	-	-	411
			03390.201	2110	Curing, membrane spray	400.00 sf	Conc 02	333.333 sf / mh	1	NOS&WB Labor Rates	33.81 /mh	41	0.06 /sf	24	-	-			1_BlueBook_2018_100%	-	-	-	-	65
					230 Concrete Pad for Dry Cooler & Pumps				109			3,714		6,811		867						3		11,394
					20 Civil/Structural				109			3,714		6,811		867						3		11,394
					10 Civil/Structural				109			3,714		6,811		867						3		11,394
30					**Purchased Mechanical Equipment**																			
	30				Purchased Equipment																			
		300			Furnish & Install Dry Cooler for Turbine 5																			
			16000.100	----	F&I Dry Cooler; 2 MM BTU/Hr Heat Rejection	1.00 ea	Elec 01	60.000 mh / ea	60	NOS&WB Labor Rates	55.74 /mh	3,344	175,000.00 /ea	175,000	-	-	3.000 mh / ea	3		85.00 /mh	255	/ea		178,599
					300 Furnish & Install Dry Cooler for Turbine 5				60			3,344		175,000				3			255			178,599
		310			Furnish & Install Circulating Water Pumps																			
			11920.001	----	Circulating Water Pumps; 20 hp	2.00 ea	Millwright 01	72.000 mh / ea	144	NOS&WB Labor Rates	54.55 /mh	7,855	25,000.00 /ea	50,000	-	-	4.000 mh / ea	8		85.00 /mh	680	-	-	58,535
					310 Furnish & Install Circulating Water Pumps				144			7,855		50,000				8			680			58,535
					30 Purchased Equipment				204			11,199		225,000				11			935			237,134
					30 Purchased Mechanical Equipment				204			11,199		225,000				11			935			237,134
40					**Piping**																			
	40				Piping																			
		400			Demo Exist Pipe/Install New Piping As Reqd.																			
			11920.001	----	Demo Existing 4" CS Piping	75.00 lf	Pipe 51	0.975 mh / lf	73	NOS&WB Labor Rates	53.78 /mh	3,933	/lf		-	-	0.200 mh / lf	15		85.00 /mh	1,275	-	-	5,208
			15209.015	270	4" Std A-53/106-B Smls Pipe (Unloading/Handling/Cutting/Etc.)	290.00 lf	Pipe 51	0.500 mh / lf	145	NOS&WB Labor Rates	53.78 /mh	7,791	12.95 /lf	3,756	-	-			1_BlueBook_2018_100%	-	-	-	-	11,546
			15209.022	40	4" Std Wt. LR 90 Ell, CS (Fit/Tack/Weld)	24.00 ea	Pipe 51	7.245 mh / ea	174	NOS&WB Labor Rates	53.78 /mh	9,352	26.66 /ea	640	-	-			1_BlueBook_2018_100%	-	-	-	-	9,992
			15209.130	50	4" 150# WN RF Flange CS (Fit/Tack/Weld)	12.00 ea	Pipe 51	4.800 mh / ea	58	NOS&WB Labor Rates	53.78 /mh	3,098	25.44 /ea	305	-	-			1_BlueBook_2018_100%	-	-	-	-	3,403
			15290.015	270	Pipe Support - Large Bore - 2-1/2" to 6"	15.00 ea	Pipe 51	3.000 mh / ea	45	NOS&WB Labor Rates	53.78 /mh	2,420	50.00 /ea	750	-	-			1_BlueBook_2018_100%	-	-	-	-	3,170
			15290.060	0090	4" Bolt & Gasket Kits, CS, 150#	12.00 ea	Pipe 51	1.650 mh / ea	20	NOS&WB Labor Rates	53.78 /mh	1,065	12.73 /ea	153	-	-			1_BlueBook_2018_100%	-	-	-	-	1,218
			15299.095	216	4" 150# CS Ball Valve, Flg	6.00 ea	Pipe 51	4.199 mh / ea	25	NOS&WB Labor Rates	53.78 /mh	1,355	466.00 /ea	2,796	-	-	0.250 mh / ea	2	1_BlueBook_2018_100%	85.00 /mh	128	-	-	4,278
					400 Demo Exist Pipe/Install New Piping As Reqd.				539			29,014		8,399				17			1,403			38,816
		410			Demo Exist Backup Pump Connections																			
			11920.001	----	Demo Existing 8" CS Piping	35.00 lf	Pipe 51	1.500 mh / lf	53	NOS&WB Labor Rates	53.78 /mh	2,824	/lf		-	-	0.200 mh / lf	7		85.00 /mh	595	-	-	3,419
			15209.028	80	8" CS Std Wt Tee (Fit/Tack/Weld)	1.00 ea	Pipe 51	36.000 mh / ea	36	NOS&WB Labor Rates	53.78 /mh	1,936	170.43 /ea	170	-	-			1_BlueBook_2018_100%	-	-	-	-	2,107
			15209.134	100	8" 150# Blind Flange CS (on old pumps & @ water supply)	3.00 ea	Pipe 51	4.500 mh / ea	14	NOS&WB Labor Rates	53.78 /mh	726	56.50 /ea	170	-	-			1_BlueBook_2018_100%	-	-	-	-	896
					410 Demo Exist Backup Pump Connections				102			5,486		340				7			595			6,421
		420			Furnish & Install New Expansion Tank																			
			15209.134	----	Furnish & Install 50 gal. Expansion Tank	1.00 ea	Pipe 51	36.000 mh / ea	36	NOS&WB Labor Rates	53.78 /mh	1,936	750.00 /ea	750	-	-	3.000 mh / ea	3		85.00 /mh	255	-	-	2,941
					420 Furnish & Install New Expansion Tank				36			1,936		750				3			255			2,941
					40 Piping				677			36,436		9,489				27			2,253			48,178
					40 Piping				677			36,436		9,489				27			2,253			48,178
60					**Electrical**																			
	60				Electrical																			
		600			Furnish & Install Electrical Equipment																			
			16421.002	----	Variable Frequency Drive; 25 Hp	2.00 ea	Elec 01	33.000 mh / ea	66	NOS&WB Labor Rates	55.74 /mh	3,679	26,500.00 /ea	53,000	-	-	3.000 mh / ea	6		85.00 /mh	510	-	-	57,189
			16421.002	----	Variable Frequency Drive; 20 Hp	2.00 ea	Elec 01	33.000 mh / ea	66	NOS&WB Labor Rates	55.74 /mh	3,679	22,500.00 /ea	45,000	-	-	3.000 mh / ea	6		85.00 /mh	510	-	-	49,189
			16421.002	----	Furnish & Install Fan Disconnect Switches	2.00 ea	Elec 01	12.000 mh / ea	24	NOS&WB Labor Rates	55.74 /mh	1,338	250.00 /ea	500	-	-				-	-	-	-	1,838
			16421.002	----	Furnish & Install Inlet Breakers	4.00 ea	Elec 01	12.000 mh / ea	48	NOS&WB Labor Rates	55.74 /mh	2,676	250.00 /ea	1,000	-	-				-	-	-	-	3,676
					600 Furnish & Install Electrical Equipment				204			11,371		99,500				12			1,020			111,891
		610			Conduit & Cable																			
			16121.510	1206	TC Jacketed Tray Cable - CU 3/C # 4 w/Gnd	960.00 lf	Elec 01	0.060 wkhr / lf	58	NOS&WB Labor Rates	55.74 /wkhr	3,211	5.50 /lf	5,280	-	-			1_BlueBook_2018_100%	-	-	-	-	8,491
			16131.110	105	GRC Conduit @ Level 1 1-1/2"	960.00 lf	Elec 01	0.203 wkhr / lf	194	NOS&WB Labor Rates	55.74 /wkhr	10,836	3.57 /lf	3,427	-	-			1_BlueBook_2018_100%	-	-	-	-	14,263
					610 Conduit & Cable				252			14,046		8,707										22,754
					60 Electrical				456			25,417		108,207				12			1,020			134,645
					60 Electrical				456			25,417		108,207				12			1,020			134,645

Estimate Totals

Description	Amount	Totals	Hours	Rate	Cost Basis	Cost per Unit	Percent of Total
Labor	76,766		1,446.2 hrs				8.94%
Material	349,507						40.70%
Subcontract	867						0.10%
Equipment	4,211		49.5 hrs				0.49%
Other Costs							
Sub Total	431,351	431,351					50.23%
Material Tax	22,718			6.500 %	C		2.65%
Equipment Rental Tax	274			6.500 %	C		0.03%
Bonds & Insurance	13			1.500 %	C		0.00%
Sub Total	23,005	454,356					2.68%
Contractor Field GC's	45,436			10.000 %	T		5.29%
Contractor OH&P	68,153			15.000 %	T		7.94%
Sub Total	113,589	567,945					13.23%
Jacobs Engg. (thru detail design)	68,153			12.000 %	T		7.94%
Sub Total	68,153	636,098					7.94%
Project Contingency	222,634			35.000 %	T		25.93%
Total		**858,732**					

Project name	19-006 SWBNO_Treated Water For Steam Turbine T4
Labor rate table	NOS&WB Labor Rates
Equipment rate table	1_BlueBook_2018_100%
Report format	Sorted by 'ITEM/Component/Task' 'Detail' summary Combine items

ITEM	Component	Task	Description	Takeoff Quantity	Labor Hours	Labor Amount	Material Price	Material Amount	Sub Price	Sub Amount	Equip Price	Equip Amount	Other Price	Other Amount	Total Amount
40			**Piping**												
	400		**Sheet 1 Pipe Modifications**												
		400	**Drawing Item #2**												
			Demo Exist 48" CIP in Clearwell & Low Lift Room	1.00 ls	**396**	**21,298**	-	**-**	-	**-**	85.00 /mh	**3,400**	-	**-**	**24,698**
			Demo River Water Connections to Pumps #6 & #7	1.00 ls	**139**	**7,454**	-	**-**	-	**-**	85.00 /mh	**2,040**	-	**-**	**9,494**
			400 Drawing Item #2		**535**	**28,753**						**5,440**			**34,193**
		404	**Drawing Item #3/#4/#5 (New Piping)**												
			48" Std A-53/106-B ERW Pipe Inside Clearwell (Unloading/Handling/Cutting/Etc.)	100.00 lf	**990**	**53,246**	186.00 /lf	**18,600**	-	**-**	-	**-**	-	**-**	**71,846**
			48" Std A-53/106-B ERW Pipe Outside Clearwell (Unloading/Handling/Cutting/Etc.)	82.00 lf	**521**	**28,016**	186.00 /lf	**15,252**	-	**-**	-	**-**	-	**-**	**43,268**
			48" Stl. to 48" DI Adapter	3.00 ea	**178**	**9,584**	6,500.00 /ea	**19,500**	-	**-**	85.00 /mh	**1,020**	-	**-**	**30,104**
			24" Std Wt. LR 90 Ell, CS (Fit/Tack/Weld)	1.00 ea	**45**	**2,430**	1,485.00 /ea	**1,485**	-	**-**	-	**-**	-	**-**	**3,915**
			42" Std Wt. LR 90 Ell, CS (Fit/Tack/Weld)	1.00 ea	**80**	**4,287**	4,800.00 /ea	**4,800**	-	**-**	-	**-**	-	**-**	**9,087**
			48" Std Wt. LR 90 Ell, CS (Fit/Tack/Weld)	2.00 ea	**180**	**9,671**	5,600.00 /ea	**11,200**	-	**-**	-	**-**	-	**-**	**20,871**
			24" CS Std Wt Tee (Fit/Tack/Weld)	1.00 ea	**67**	**3,585**	2,958.10 /ea	**2,958**	-	**-**	-	**-**	-	**-**	**6,543**
			48" CS Std Wt Tee (Fit/Tack/Weld)	1.00 ea	**130**	**6,972**	7,600.00 /ea	**7,600**	-	**-**	-	**-**	-	**-**	**14,572**
			Spring & Roller Pipe Supports	16.00 ea	**1,109**	**59,636**	1,500.00 /ea	**24,000**	-	**-**	85.00 /mh	**4,080**	-	**-**	**87,716**
			8" Tall Structural Steel Stanchions	16.00 ea	**950**	**51,116**	1,100.00 /ea	**17,600**	-	**-**	85.00 /mh	**4,080**	-	**-**	**72,796**
			48" x 42" CS Std Wt Red (Fit/Tack/Weld)	1.00 ea	**85**	**4,545**	5,500.00 /ea	**5,500**	-	**-**	-	**-**	-	**-**	**10,045**
			404 Drawing Item #3/#4/#5 (New Piping)		**4,334**	**233,090**		**128,495**				**9,180**			**370,765**
			400 Sheet 1 Pipe Modifications		**4,868**	**261,842**		**128,495**				**14,620**			**404,958**
	410		**Sheet 2 Pipe Modifications**												
		406	**Drawing Item #2 (pipe demo)**												
			Demo Pump Suction (UG & AG Piping)	1.00 ls	**462**	**24,848**	-	**-**	-	**-**	85.00 /mh	**10,200**	-	**-**	**35,048**
			406 Drawing Item #2 (pipe demo)		**462**	**24,848**						**10,200**			**35,048**
		408	**Drawing Items #2,#3, & #4 (new UG piping)**												
			48" Std A-53/106-B ERW UG/AG Piping	275.00 lf	**1,656**	**89,076**	220.00 /lf	**60,500**	-	**-**	85.00 /mh	**29,219**	-	**-**	**178,795**
			48" Stl. to 42" Adapter	1.00 ea	**59**	**3,195**	6,500.00 /ea	**6,500**	-	**-**	85.00 /mh	**340**	-	**-**	**10,035**
			48" Std Wt. LR 90 Ell, CS (Fit/Tack/Weld)	2.00 ea	**180**	**9,671**	5,600.00 /ea	**11,200**	-	**-**	-	**-**	-	**-**	**20,871**
			48" Std Wt. LR 45 Ell, CS (Fit/Tack/Weld)	2.00 ea	**180**	**9,671**	5,000.00 /ea	**10,000**	-	**-**	-	**-**	-	**-**	**19,671**
			48" x 42" CS Std Wt Red (Fit/Tack/Weld)	1.00 ea	**85**	**4,545**	5,500.00 /ea	**5,500**	-	**-**	-	**-**	-	**-**	**10,045**
			408 Drawing Items #2,#3, & #4 (new UG piping)		**2,160**	**116,159**		**93,700**				**29,559**			**239,418**
			410 Sheet 2 Pipe Modifications		**2,622**	**141,007**		**93,700**				**39,759**			**274,466**
	420		**Sheet 3 Pipe Modifications**												
		410	**Drawing Item #2 Demo Exist 48" Fittings & Valve R17**												
			Demo Exist 48" Piping & Valve R17	1.00 ls	**363**	**19,524**	-	**-**	-	**-**	85.00 /mh	**3,570**	-	**-**	**23,094**
			410 Drawing Item #2 Demo Exist 48" Fittings & Valve R17		**363**	**19,524**						**3,570**			**23,094**
		412	**Drawing Items #2-#4 Pipe Demo. & New Piping**												
			48" Std A-53/106-B ERW Piping	18.00 lf	**108**	**5,830**	220.00 /lf	**3,960**	-	**-**	85.00 /mh	**1,913**	-	**-**	**11,703**
			48" Stl. to 48" DI Adapter	2.00 ea	**119**	**6,390**	6,500.00 /ea	**13,000**	-	**-**	85.00 /mh	**680**	-	**-**	**20,070**
			48" Std Wt. LR 90 Ell, CS (Fit/Tack/Weld)	2.00 ea	**180**	**9,671**	5,600.00 /ea	**11,200**	-	**-**	-	**-**	-	**-**	**20,871**
			412 Drawing Items #2-#4 Pipe Demo. & New Piping		**407**	**21,891**		**28,160**				**2,593**			**52,644**
			420 Sheet 3 Pipe Modifications		**770**	**41,415**		**28,160**				**6,163**			**75,737**
	430		**Sheet 9 Pipe Modifications**												
		414	**Drawing Items #2-#4 Pipe Demo. & New Piping**												
			48" Std A-53/106-B ERW Piping	103.00 lf	**620**	**33,363**	220.00 /lf	**22,660**	-	**-**	85.00 /mh	**10,944**	-	**-**	**66,967**
			Demo Exist 48" Piping As Reqd.	1.00 ls	**231**	**12,424**	-	**-**	-	**-**	85.00 /mh	**3,060**	-	**-**	**15,484**
			48" Stl. to 48" DI Adapter	1.00 ea	**59**	**3,195**	6,500.00 /ea	**6,500**	-	**-**	85.00 /mh	**340**	-	**-**	**10,035**
			48" Std Wt. LR 90 Ell, CS (Fit/Tack/Weld)	5.00 ea	**450**	**24,178**	5,600.00 /ea	**28,000**	-	**-**	-	**-**	-	**-**	**52,178**
			Spring & Roller Pipe Supports	2.00 ea	**139**	**7,454**	1,500.00 /ea	**3,000**	-	**-**	85.00 /mh	**510**	-	**-**	**10,964**
			414 Drawing Items #2-#4 Pipe Demo. & New Piping		**1,499**	**80,615**		**60,160**				**14,854**			**155,628**
			430 Sheet 9 Pipe Modifications		**1,499**	**80,615**		**60,160**				**14,854**			**155,628**
			40 Piping		**9,759**	**524,879**		**310,515**				**75,395**			**910,789**

Estimate Totals

Description	Amount	Totals	Hours	Rate	Cost Basis	Cost per Unit	Percent of Total
Labor	524,879		9,759.0 hrs				28.61%
Material	310,515						16.93%
Subcontract							
Equipment	75,395		887.0 hrs				4.11%
Other Costs							
Sub Total	910,789	910,789					49.65%
Material Tax	20,183			6.500 %	C		1.10%
Equipment Rental Tax	4,901			6.500 %	C		0.27%
Bonds & Insurance				1.500 %	C		
Sub Total	25,084	935,873					1.37%
Contractor Field GC's	93,587			10.000 %	T		5.10%
Contractor OH&P	140,381			15.000 %	T		7.65%
Sub Total	233,968	1,169,841					12.76%
Jacobs Enge. (thru detail deisgn)	140,381			12.000 %	T		7.65%
Sub Total	140,381	1,310,222					7.65%
Project Contingency	524,089			40.000 %	T		28.57%
Total		**1,834,311**					

Project name	19-006 SWBNO_Electric Conversion on A&B Pumps
Labor rate table	NOS&WB Labor Rates
Equipment rate table	1_BlueBook_2018_100%
Report format	Sorted by 'ITEM/Component/Task' 'Detail' summary Combine items

ITEM	Component	Task	Description	Takeoff Quantity	Labor Hours	Labor Amount	Material Price	Material Amount	Sub Price	Sub Amount	Equip Price	Equip Amount	Other Price	Other Amount	Total Amount
10			**Purchase Equip. to Replace Steam Turbines on Pumps A&B**												
	60		Electrical												
		600	Purchase 2000 Hp, 4160 V Electric Motors												
			Electric Motors; 2000 Hp, 4160 V, 900 rpm	2.00 ea			190,000.00 /ea	**380,000**	-	**-**	85.00 /mh		-	**-**	**380,000**
			600 Purchase 2000 Hp, 4160 V Electric Motors					**380,000**							**380,000**
		610	Purchase 2000 Hp VFD's												
			2000 Hp Variable Frequency Drive	2.00 ea		-	600,000.00 /ea	**1,200,000**	-	**-**	-	**-**	- /ea	**-**	**1,200,000**
			610 Purchase 2000 Hp VFD's					**1,200,000**							**1,200,000**
			60 Electrical					**1,580,000**							**1,580,000**
			10 Purchase Equip. to Replace Steam Turbines on Pumps A&B					**1,580,000**							**1,580,000**
20			**Demolition of Equipment Abandoned by Electrification**												
	60		Electrical												
		615	Demo Scope Listed in Item #1												
			Demo Steam Turbines; 2250 Hp	2.00 ea	**1,600**	**87,274**	-	**-**	-	**-**	135.00 /mh	**10,800**	-	**-**	**98,074**
			Demo Lubrication System & Steam Lines	1.00 ls	**120**	**6,546**	-	**-**	-	**-**	85.00 /mh	**680**	-	**-**	**7,226**
			Demo 30' of 6" & 60' of 18" Piping	1.00 ls	**96**	**5,163**	-	**-**	-	**-**	85.00 /mh	**1,020**	-	**-**	**6,183**
			Demo Steam Turbine Foundations	2.00 ea	**320**	**10,848**	-	**-**	-	**-**	125.00 /mh	**10,000**	-	**-**	**20,848**
			615 Demo Scope Listed in Item #1		**2,136**	**109,831**						**22,500**			**132,331**
		620	Demo Scope Listed in Item #2												
			Demo Condensers	2.00 ea	**240**	**13,091**	-	**-**	-	**-**	135.00 /mh	**3,240**	-	**-**	**16,331**
			620 Demo Scope Listed in Item #2		**240**	**13,091**						**3,240**			**16,331**
		625	Demo Scope Listed in Item #3												
			Demo Steam Driven Condensate Pump	2.00 ea	**80**	**4,364**	-	**-**	-	**-**	85.00 /mh	**680**	-	**-**	**5,044**
			Demo 80' of 4" Piping	1.00 ls	**48**	**2,582**	-	**-**	-	**-**	85.00 /mh	**255**	-	**-**	**2,837**
			625 Demo Scope Listed in Item #3		**128**	**6,945**						**935**			**7,880**
		630	Demo Scope Listed in Item #4												
			Demo Steam Jet Air Ejectors	2.00 skids	**80**	**4,364**	-	**-**	-	**-**	135.00 /mh	**810**	-	**-**	**5,174**
			Demo 100' of 2" & 80' of 4" Piping	1.00 ls	**120**	**6,454**	-	**-**	-	**-**	85.00 /mh	**2,040**	-	**-**	**8,494**
			630 Demo Scope Listed in Item #4		**200**	**10,818**						**2,850**			**13,668**
		635	Demo Scope Listed in Item #5												
			Demo Turbine Driven Cooling Water Pump Skids	3.00 skids	**120**	**6,546**	-	**-**	-	**-**	135.00 /mh	**1,215**	-	**-**	**7,761**
			Remove & Re-Install 25' Metal Stairway	1.00 ls	**120**	**6,164**	-	**-**	-	**-**	85.00 /mh	**1,360**	-	**-**	**7,524**
			635 Demo Scope Listed in Item #5		**240**	**12,710**						**2,575**			**15,285**
		640	Demo Scope Listed in Item #6												
			Demo 100' of 18" Piping	1.00 ls	**64**	**3,442**	-	**-**	-	**-**	85.00 /mh	**340**	-	**-**	**3,782**
			640 Demo Scope Listed in Item #6		**64**	**3,442**						**340**			**3,782**
		645	Demo Scope Listed in Item #7												
			Demo 150' of 1" Piping	1.00 ls	**16**	**861**	-	**-**	-	**-**	/mh		-	**-**	**861**
			Demo 100' of 6" & 100' of 18" Piping	1.00 ls	**128**	**6,884**	-	**-**	-	**-**	85.00 /mh	**1,360**	-	**-**	**8,244**
			645 Demo Scope Listed in Item #7		**144**	**7,745**						**1,360**			**9,105**
			60 Electrical		**3,152**	**164,582**						**33,800**			**198,382**
			20 Demolition of Equipment Abandoned by Electrification		**3,152**	**164,582**						**33,800**			**198,382**
30			**Turbine 6 Unit Substation**												
	60		Electrical												
		650	Scope Item #1												
			Ductbank (incl. conduit)	400.00 lf	**145**	**8,108**	85.00 /lf	**34,000**	-	**-**	35.00 /mh	**1,273**	-	**-**	**43,380**
			Power Cable CU 3/C #350 w/Gnd	800.00 lf	**106**	**5,931**	31.31 /lf	**25,048**	-	**-**	-	**-**	-	**-**	**30,979**
			650 Scope Item #1		**252**	**14,038**		**59,048**				**1,273**			**74,359**
		655	Scope Item #2												
			Provide 3" Housekeeping Pads	2.00 ea	**60**	**2,746**	150.00 /ea	**300**	-	**-**	25.00 /mh	**300**	-	**-**	**3,346**
			Install VFD Drives in Pump Room	2.00 ea	**160**	**8,918**	-	**-**	-	**-**	85.00 /mh	**1,360**	-	**-**	**10,278**
			655 Scope Item #2		**220**	**11,665**		**300**				**1,660**			**13,625**
		660	Scope Item #3												
			GRC Conduit @ Level 1 4"	80.00 lf	**36**	**2,007**	13.03 /lf	**1,042**	-	**-**	-	**-**	-	**-**	**3,049**
			660 Scope Item #3		**36**	**2,007**		**1,042**							**3,049**
		665	Scope Item #4												
			Provide New Concrete Pedestals for Motors	4.00 cy	**64**	**2,929**	250.00 /cy	**1,000**	-	**-**	25.00 /mh	**1,600**	-	**-**	**5,529**
			665 Scope Item #4		**64**	**2,929**		**1,000**				**1,600**			**5,529**
		670	Scope Item #5												
			Modify Existing Strutural Steel for Support	3.00 tons	**150**	**7,705**	3,850.00 /tons	**11,550**	-	**-**	85.00 /mh	**6,120**	-	**-**	**25,375**
			670 Scope Item #5		**150**	**7,705**		**11,550**				**6,120**			**25,375**
		675	Scope Item #6												
			Install & Algin New Pump Motors	2.00 ea	**108**	**6,020**	100.00 /ea	**200**	-	**-**	85.00 /mh	**680**	-	**-**	**6,900**
			675 Scope Item #6		**108**	**6,020**		**200**				**680**			**6,900**
		680	Scope Item #7												
			Commission Each New Pump	2.00 ea	**72**	**4,013**	/ea		-	**-**	/mh		-	**-**	**4,013**

ITEM	Component	Task	Description	Takeoff Quantity	Labor Hours	Labor Amount	Material Price	Material Amount	Sub Price	Sub Amount	Equip Price	Equip Amount	Other Price	Other Amount	Total Amount
			680 Scope Item #7		72	4,013									4,013
		685	Scope Item #7												
			Training of Plant Personnel	16.00 hrs		4,000	-	-	-	-	-	-	-	-	4,000
			685 Scope Item #7			4,000									4,000
			60 Electrical		902	52,377		73,140				11,333			136,850
			30 Turbine 6 Unit Substation		902	52,377		73,140				11,333			136,850

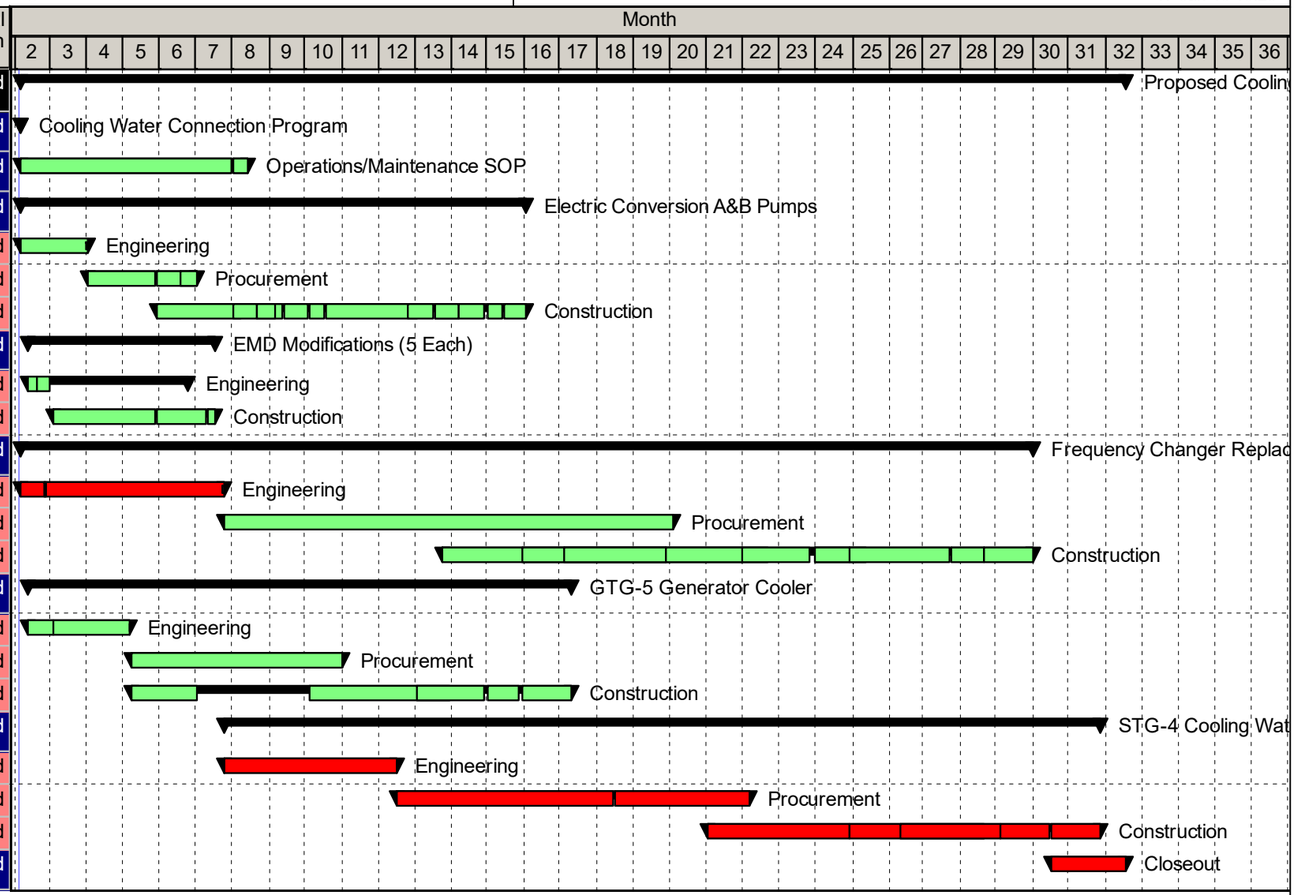
Estimate Totals

Description	Amount	Totals	Hours	Rate	Cost Basis	Cost per Unit	Percent of Total
Labor	216,959		4,053.9 hrs				5.67%
Material	1,653,140						43.18%
Subcontract							
Equipment	45,133		498.4 hrs				1.18%
Other Costs							
Sub Total	1,915,232	1,915,232					50.03%
Material Tax	107,454			6.500 %	C		2.81%
Equipment Rental Tax	2,934			6.500 %	C		0.08%
Bonds & Insurance				1.500 %	C		
Sub Total	110,388	2,025,620					2.88%
Contractor Field GC's	202,562			10.000 %	T		5.29%
Contractor OH&P	303,843			15.000 %	T		7.94%
Sub Total	506,405	2,532,025					13.23%
Jacobs Enge. (thru detail deisgn)	303,843			12.000 %	T		7.94%
Sub Total	303,843	2,835,868					7.94%
Project Contingency	992,554			35.000 %	T		25.93%
Total		**3,828,422**					

Attachment 3
Schedules

Proposed Cooling Water Transition Schedule R1	Cooling Water Study Transition Schedule	17-Jan-19 10:28

Activity ID	Activity Name	Original Duration
	Proposed Cooling Water Transition Schedule R1	645d
	Cooling Water Connection Program	0d
	Operations/Maintenance SOP	135d
	Electric Conversion A&B Pumps	294d
	Engineering	40d
	Procurement	65d
	Construction	214d
	EMD Modifications (5 Each)	110d
	Engineering	95d
	Construction	95d
	Frequency Changer Replacement for STG-3	590d
	Engineering	120d
	Procurement	260d
	Construction	345d
	GTG-5 Generator Cooler	315d
	Engineering	60d
	Procurement	125d
	Construction	255d
	STG-4 Cooling Water Modifications	510d
	Engineering	100d
	Procurement	205d
	Construction	230d
	Closeout	45d



Remaining Level of Effort
Actual Work
Remaining Work
Critical Remaining Work
Summary

JACOBS®